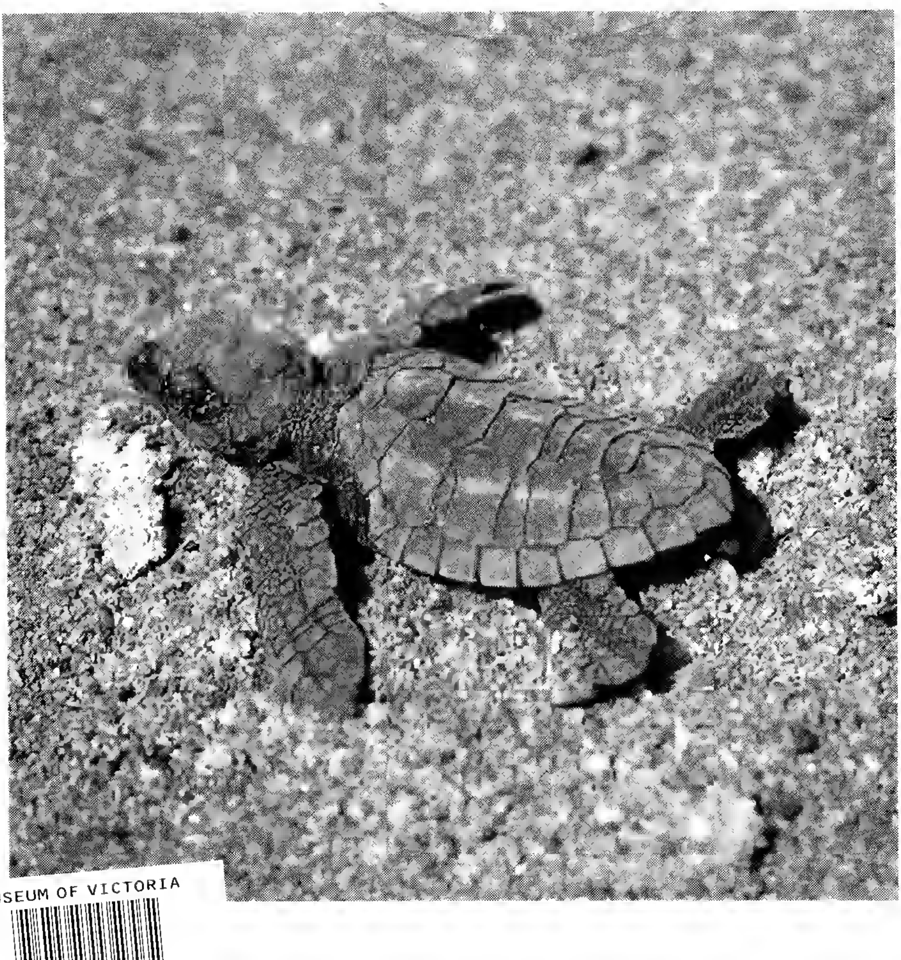
NORTHERN TERRITORY NATURALIST



NT Field Naturalists' Club 1990 No.12

NORTHERN TERRITORY FIELD NATURALISTS' CLUB - FOUNDED 1977

The objectives of the Northern Territory Field Naturalists' Club are to promote the study and conservation of the flora and fauna of the Northern Territory. The club holds monthly meetings and field excursions. Meetings are held in the Northern Territory Museum of Arts and Sciences theatrette, Darwin, at 7:45 pm on the second Wednesday of each month.

All members receive the bimonthly newsletter *Nature Territory*, and the annual journal *Northern Territory Naturalist*. For information on membership rates, club activities and publications please write to:

Northern Territory Field Naturalists' Club
P.O. Box 39565 Winnellie, NT 0821.

Advice to contributors

The *NT Naturalist* publishes original papers treating any aspect of the natural history of the Northern Territory or elsewhere in northern Australia. Contributors to the *NT Naturalist* need not be members of the NT Field Naturalists' Club. Submissions are considered on the understanding that they are being offered for publication solely by the NT Field Naturalists' Club, which will retain copywright. All manuscripts are refereed.

Manuscripts should be in duplicate, typewritten and double-spaced with generous margins. To facilitate revision, the use of a word processor is strongly advised. Authors should consult a recent issue of *NT Naturalist* for style and layout.

Articles should be written in a manner intelligible to readers without a specialist knowledge of the subject. They should be appropriately illustrated with clear, black ink graphs, diagrams or photographs. Reports of less than 500 words detailing observations of something new or unusual in the field, for example on the behaviour of an animal, will be published as Short Notes.

COVER: Hatchling Ridley Turtle *Lepidochelys olivacea*, NW Crocodile Island (M. Guinea)

COMMENTARY

Cape York: Is it the Biogeographic Key to Northern Australia?

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Unlike the southern stretch of our great island continent, northern Australia has a remarkable uniformity of vegetation (Bowman & Wilson 1986). The eucalypt formations that grow on the Great Dividing Range along the east coast fade into scattered patches in the eastern corner of South Australia (Carnahan 1976). The forests and woodlands on the other side of the Nullarbor have a significantly different flora to that of the east, reflecting a long period of isolation (Burbidge 1960). In northern Australia this east-west division is less obvious. For example, the *Eucalyptus tetrodonta* savannas occur from Weipa to the Kimberley, as do many other forest types (Specht et al. 1974; Specht et al. 1977). Perhaps the most interesting of these are the monsoon forests which are commonly known as rainforests, jungles or monsoon vine forests.

Patches of monsoon forest are scattered throughout the areas of northern Australia which receive summer rains and have a winter drought. These patches are thought to be the last vestiges of the great rainforest that covered northern Australia and which was destroyed by adverse climatic changes (Singh 1982), a concept which is topical because of concern about the "greenhouse effect". Monsoon forests are richest in species and largest in extent in areas which receive high rainfall (Russell-Smith 1988). In drier regions like the Gulf of Carpentaria, Victoria River District, inland areas in the Kimberley and the coastal parts of the Pindan (the most westerly monsoon forest is at Broome) jungles are typically small in area and have fewer constituent species (Wightman & Andrews 1989).

On Cape York this relationship between rainfall and rainforest complexity is amplified. The mountains of the Great Dividing Range intercept moisture from the Pacific ocean. On the wet eastern slopes complex rainforests dominate. They are ecological and taxonomic research frontiers. Given that these mountains are geologically stable and that the Aborigines did not practice slash and burn agriculture, many ancient rainforest plant species have survived. These complex forests are also the home of relictual vertebrates like Cassowary *Casuarius casuarius*, Spotted *Phalanger maculatus* and Grey Cuscus *P. orientalis*, Striped possum *Dactylopsila trivirgata* and Giant Mosaic-tailed Rat *Uromys caudimaculatus*. Most of the rainforest mammals died out over the last 30 to 15 million years; at Riversleigh in the Gulf there are more fossil species of marsupial than are alive today (Archer *et al.* 1986). On the western slopes of the Cape York mountains the complex rainforests grade into floristically simpler rainforests with a lower stature

and fewer large woody vines and rattans (lawyer vines). On the plains surrounding the foothills is a widespread eucalypt savanna. On river flats gallery rainforests spread across the Cape providing important routes for the spread of rainforest organisms.

Some of the scattered monsoon forests on the western side of Cape York are structurally identical to those that occur in the wetter regions of the Top End and the Kimberley. The surrounding savannas are also similar to those in the north-west with Darwin stringy barks *E. tetrodonta* and Melville Island bloodwoods *E. nesophila* dominating the forests (Specht *et al.* 1977). However the savannas and monsoon forests on the Cape have many species which do not occur in the NT or Kimberley. This difference probably reflects their proximity to the large expanses of complex rainforest on the wetter east coast of the Cape, and to Torres Strait which is an important route for the biological invasion of Australia.

Some of the Cape York monsoon forest patches are much larger than their more western counterparts (O'Neill *et al.* 1988). These big monsoon forest patches contain a wide variety of rainforest mammals and birds in marked contrast to monsoon forests of the NT and WA which are known to have few vertebrate rainforest specialists (Martin & Freeland 1988).

Australia's largest complex rainforest (on the McIllwraith Range) and monsoon forest (near Weipa) occur on Cape York (O'Neill *et al.* 1988). Both these vegetation types were once far more widespread and have been replaced by the more recently evolved and highly successful eucalypt savannas (Specht 1988). The juxtaposition of these habitats provides a remarkable opportunity to understand their interrelationships. Many of the questions that students of northern Australian monsoon forest ecology struggle with, such as: why are our monsoon forests lacking vertebrate specialists?; why are the NT and WA monsoon forests so limited in spatial extent?; and how have the monsoon forests survived through periods of aridity during the ice ages?; may in fact be best tackled on Cape York.

Furthermore, only on Cape York is it possible to understand the relationship between complex rainforest and monsoon forests. These questions are of fundamental scientific interest but also have practical implications. They can teach us about the consequences of past climatic change and the possible effects of future climatic changes. One of the great blanks in our knowledge of northern Australian ecology is the environmental history of the region. Most of our knowledge of environmental history is limited to the complex rainforests on Atherton (Singh 1981). Consequently it is difficult to speculate what the consequences of the greenhouse effect will be for the Australian monsoon tropics.

Cape York is perhaps akin to the Rosetta stone - the stone tablet that allowed scholars to understand previously unintelligible dead languages - it may hold the key to understanding northern Australian biogeography. We can only anticipate the exciting biological research that is still to be carried out on the Cape.

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Notes on Sea Turtle Rookeries on the Arafura Sea Islands of Arnhem Land, Northern Territory

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Abstract

Selected islands of the southern Arafura sea were surveyed for sea turtle nesting during June - July 1989. The numbers of Olive Ridley Turtles *Lepidochelys olivacea* and Flatback Turtles *Natator depressus* nesting on Marchinbar, Cape Wessel, NW Crocodile, Grant and New Year Islands are presented. Sand temperatures at nest depth on nesting beaches varied from 26.8°C on New Year Island to 30.1°C on NW Crocodile Island. Scale counts of hatchlings, egg dimensions and clutch information are presented for each species. Careful consideration of the impact of pollution and future development in the area is urged.

Introduction

Previous reports of sea turtle nesting in the Northern Territory are sporadic and in part based on anecdotal evidence. The islands to the west of Darwin (Indian, Bare Sand, Quail and West Peron) are important nesting areas for the Flatback Turtle *Natator depressus* (Fry 1913; Pritchard 1977) as are the Sir Edward Pellew Islands in the south western Gulf of Carpentaria (Cogger 1968 a, b). The sandy inlets and islands of Cobourg Peninsula and elsewhere off the Arnhem Land coast support breeding populations of Flatback and Olive Ridley Turtle *Lepidochelys olivacea* (Cogger & Lindner 1969). Large numbers of the Green Turtle *Chelonia mydas* occur in the western Gulf of Carpentaria (Limpus & Reed 1985; Marsh *et al.* 1986).

Further observations on the sea turtles nesting on the islands off the north coast of Arnhem Land are reported here. The islands were selected on the basis of reports of turtle tracks by Coastwatch Air Surveillance aircraft and by nomination by local members of Arnhem Land communities as turtle nesting sites.

Study Area

The islands investigated extend from Cape Wessel in north east Arnhem Land to New Year Island, east of Cobourg Peninsula and included Cape Wessel, Two Island and Jensen Bays on Marchinbar Island, North West Crocodile and Grant Islands (Fig. 1). The region experiences semi-diurnal tides with a mean spring tidal range of 2.8 m and a mean neap range of 1.4 m. The survey was conducted from 29 June to 4 July 1989, during a period of the waning moon (new moon on 3 July). The islands displayed a variety of sands ranging from white silica beaches (Marchinbar I), a mixture of iron, silica and calcium carbonate (NW Crocodile I) and pure calcium carbonate (New Year I). All were vegetated with typical strand vegetation including *Pemphis acidula*, grasses and herbs.

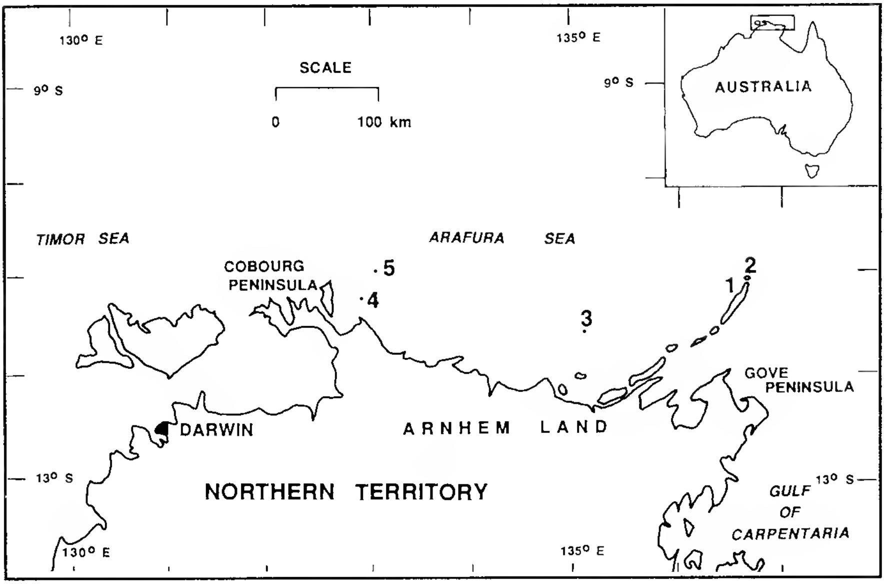

FIGURE 1 *The islands of the Arafura Sea that were surveyed for sea turtle nesting activity in June and July 1989. (1) Marchinbar Island, (2) Cape Wessel, (3) NW Crocodile Island, (4) Grant Island, and (5) New Year Island.*

Methods

Each locality was visited for at least several hours during which as much of the island as possible was inspected for turtle tracks and nests. The width and symmetry of tracks were used to determine the species concerned. Ridley tracks had a maximum width of 75 cm and displayed an asymmetric pattern produced from an alternating gait (Type B, Limpus 1971). Flatback tracks were wider (96 cm), and symmetric in pattern (Type A, Limpus 1971; Limpus *et al.* 1988).

Recently laid nests were opened and the clutch counted. A sample of ten eggs, where possible, from each clutch was weighed (Pesola spring balance ±0.1 g) and measured (Vernier callipers, ±0.05 mm). Sand temperatures were measured with a mercury-in-glass thermometer (±0.2°C). Temperature readings were taken from the base of the egg chamber and in holes dug to a depth of 50 cm in the beach near the turtle nests. The methods and terminology follow those used by Limpus *et al.* (1983a). The number of nests with visible tracks were counted to give an indication of the nesting activity over the previous month. The number of hatched nests was used as an indication of nesting activity 45 to 55 days prior to the survey (Cogger & Lindner 1969).

TABLE 1 *The number of nests (fresh / hatched) of Ridley and Flatback Turtles at each locality visited during the survey. Sand temperatures measured at nest depth (mean ± standard deviation, sample size in parentheses).*

Locality	*Ridley*	*Flatback*	*Sand Temp°C*
Jensen Bay	1/1	0/0	28.5 ± -- (1)
Cape Wessel	3/4	0/0	27.1 ± 1.0 (5)
N.W. Crocodile	14/10	22/4	30.1 ± 0.7 (4)
Grant	32/0	0/2	28.0 ± 1.4 (2)
New Year	38/4	0/0	26.8 ± 1.1 (2)

Results

1. *Jensen Bay, Marchinbar Island*

In Jensen Bay on the west coast of Marchinbar Island a single recent Ridley nest was located (Table 1). A visit to Two Island Bay, four kilometres to the north of Jensen Bay, revealed no evidence of sea turtle nesting in the last month. However, members of the Jensen Bay outstation stated that nesting did occur there.

2. *Cape Wessel*

There was no sign of nesting activity on the western beach, but four turtle nests had recently hatched on the eastern side. Ridley hatchlings were collected from one nest. The carapace, plastron, head and limbs of the hatchlings were generally black in colour with only the distal edge of the marginal and supracaudal scales tipped with white. Three low longitudinal ridges were present along the carapace. The remaining hatched nests had been opened by goannas (*Varanus* sp), but the eggs were of a size which was consistent with those of a Ridley. All nests were below the vegetation at the base of the dune.

Three recently laid nests with Ridley-like tracks were located on the south-eastern part of the island. One clutch of 88 contained embryos which were approximately 20 mm long [stage 23 of Miller (1985)], the diameter and mass of the eggs were not recorded because of errors associated with water absorption. A second nest contained 138 eggs but the third had been opened by goannas leaving only three eggs intact.

Other species of turtle may nest on the island but from the width of the tracks it appeared that only the Ridley nested at the time of my survey. Tracks in coral shingle on the north west side of the island indicated possible nests but none were located. The remains of turtle egg shells beside a deserted aboriginal camp suggested that a species having an egg much larger than that of the Ridley had been consumed there at some time in the past.

While sailing to the Crocodile Islands, the vessel passed an adult Ridley basking at the surface (15:00 hr; water temperature, 26.0°C). At that locality (11° 14'S., 136° 22'E.) the depth was 30 to 60 m.

3. *North West Crocodile Island*

North West Crocodile Island consisted of ironstone and iron stained sand. Dunes to a height of 10 m were located at the south-eastern end of the island. The remainder of the coast comprised sand and beach rock. There was no evidence of goannas and the island supported a colony of Crested Terns *Sterna bergii*.

Ridley and Flatback tracks were common on the island. As surface sand temperatures (55°C+) during the survey may have been lethal to embryos, freshly laid nests were not opened. On a 1 km sample of the beach at the north-western point of the island, 14 Ridley and 22 Flatback nests were counted with obvious recent tracks. On the same beach, 10 Ridley and 4 Flatback nests had hatched in recent days. As approximately 25 % of the available nesting beach was thoroughly surveyed, the number of recent nests on the island may be four times those that were recorded. The hatched nest data indicates that, in contrast to July, Ridley nestings in mid-April outnumbered those of the Flatback.

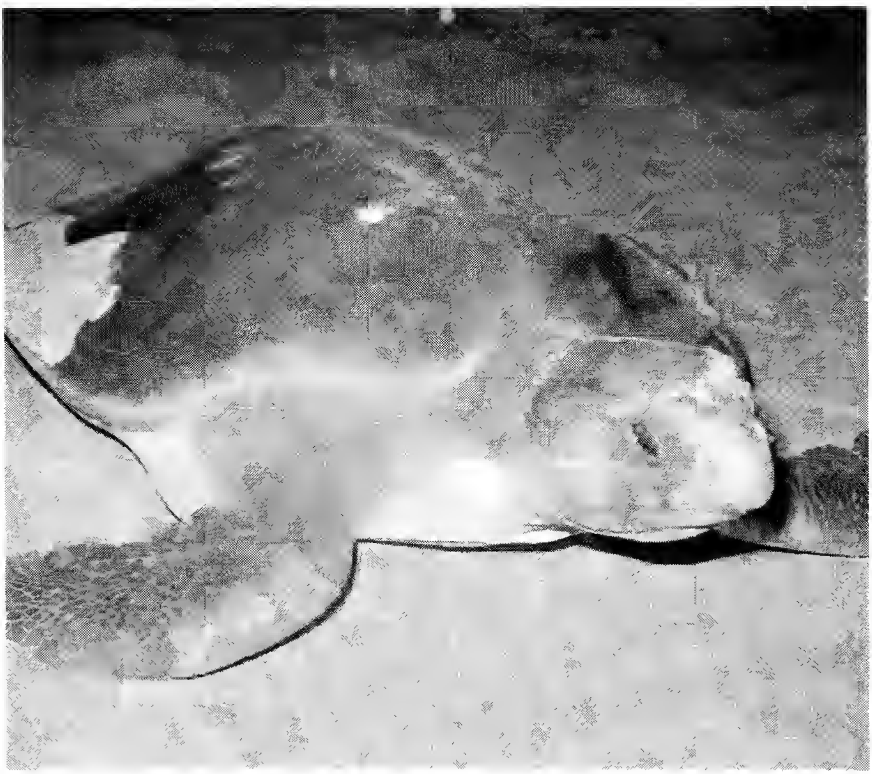

PLATE 1 Adult Flatback Turtle *Natator depressus* at Fog Bay, west of Darwin (M. Guinea)

TABLE 2 *Nest and egg data for Ridley and Flatback turtles from the islands of the southern Arafura Sea. Sand depth measured to the top and to the bottom of the egg chamber. Hatching success of the nests given as percentage of eggs that produced live hatchlings. Values indicate mean ± standard deviation; sample size in parenthesis.*

	Ridley	*Flatback*
Clutch size	101.5 ± 19.1 (7)	45.5 ± 2.1 (2)
Egg diameter (mm)	36.7 ± 1.5 (23)	–
Egg mass (g)	26.1 ± 2.9 (23)	–
Nest depth (cm)		
Top	29.3 ± 4.0 (7)	29.5 ± 6.4 (2)
Bottom	49.1 ± 3.7 (7)	52.0 ± 7.1 (2)
Hatching success (%)	81.0 ± 6.6 (4)	98.9 ± 1.5 (2)

TABLE 3 *Scale counts, carapace dimensions and mass of hatchlings of Ridley and Flatback turtles from Cape Wessel and N.W. Crocodile Island. Scale counts indicate number of scales on left/right sides of body, followed in parentheses by number of turtles with that count. Carapace dimensions indicate mean (± standard deviation) of the Straight Carapace Length (SCL) and Straight Carapace Width (SCW). Mass, where applicable, is indicated as mean (± standard deviation).*

	Ridley	*Flatback*
SCALES		
Nuchal	0 (1), 1 (11), 2 (7)	1 (2)
Central	6 (7), 7 (12)	5 (2)
Supracaudal	2 (19)	2 (2)
Costal L/R	6/6 (4), 6/7 (1), 7/6 (1), 7/7 (6), 7/8 (1), 8/7 (1), 8/8 (4), 9/9 (1)	4/4 (2)
Marginal L/R	12/12 (15), 12/13 (2), 13/13 (2)	11/11 (2)
Inframarginal	4/4 (19)	4/4 (2)
Postocular	3/3 (11), 3/4 (3), 4/3 (4), 4/4 (1)	3/3 (2)
Prefrontal	4 (12), 5 (5), 6 (2)	2 (2)
CARAPACE		
SCL (mm)	41.0 (± 1.9)	55.6 (± 2.8)
SCW (mm)	33.1 (± 1.7)	47.7 (± 6.4)
MASS (g)	15.3 (± 2.0)	10.1(dehydrated), 28.9
SAMPLE SIZE	19 (3 clutches)	2 (2 clutches)

The charred remains of three adult turtles were found beside a fire place at a camp-site on the eastern side of the island. On the southern point of the island an adult female Ridley was found dead on her back. The animal had tumbled over a ledge of beach rock as she returned to the sea. Having landed on her carapace she was unable to right herself and perished. Two Flatback hatchlings were found tangled in grass in the dunes. One had been air dried by dehydration, the other was alive but died soon after capture.

4. *Grant Island*

Grant Island has a well established eucalypt woodland and narrow beaches with little sand dune development. There was no visible evidence of goannas opening turtle nests. A total of 32 Ridley nests were located on the southern, western and northern beaches. Two hatched Flatback nests were located and verified by the empty shells of their characteristically large eggs.

5. *New Year Island*

New Year Island is the most northern island in the Northern Territory. It is a lone sand cay with a central lagoon containing mangroves. The common strand plant *Pemphis acidula* formed an inpenetrable thicket at the top of the shingle bank. The rising tide restricted this survey to the shingle banks of the southern and eastern sides of the island. A total of 38 recent Ridley nests were located on 500 m of beach. Four sets of hatchling tracks were observed but their nests could not be located amongst the shingle and *Pemphis*. There was neither evidence of Flatback nesting nor of egg predation by goannas.

Discussion

The survey revealed that Flatback and Ridley turtles nest in the Northern Territory during the winter months (June, July). NW Crocodile and Grant, support both species. Cape Wessel supports Ridley nesting and possibly Flatback, while New Year Island supports only Ridleys (Table 1). Further investigations into the possible relationship between distance from the coast, composition and texture of the beaches and the turtle species nesting in each locality seem promising.

Reports of nesting in late Summer (March-April) and winter (August) by Flatback and Ridley turtles at Cobourg Peninsula (Cogger & Lindner 1969) suggest a protracted nesting season in Northern Territory waters. Crab Island in the Gulf of Carpentaria, which has a similar latitude to the islands in this survey, has year-round nesting of Flatbacks with a peak in activity in August (Limpus *et al.* 1983).

Anthropological surveys indicate that it is not until the early dry season (May to July) that the aboriginal people of Arnhem Land start turtle egg collecting trips to the islands of the Arafura Sea. Apart from the collection of Flatback and Ridley eggs, those of the Green Turtle and Hawksbill Turtle *Eretmochelys imbricata* are harvested along with eggs of the Crested Tern (Davis 1985, 1989).

The mean clutch size obtained from the two hatched nests of Flatbacks (Table 2) is within one standard deviation (10.7) of the mean clutch size (50.2) reported for Mon Repos in south-eastern Queensland (Limpus 1971) and within the range for this species at Cobourg Peninsula (Cogger & Lindner 1969). The scale counts

of hatchlings (Table 3) agree with the modal counts for the respective scales of this species at Cobourg Peninsula (Cogger & Lindner 1969), Mon Repos (Limpus 1971) and Crab I (Limpus *et al.* 1983a).

Ridley turtles are seldom encountered in eastern Australia (Limpus 1975; Limpus *et al.* 1981; Limpus & Roper 1981; Limpus 1982) so the few observations presented here represent a significant addition to those already presented by Cogger & Lindner (1969). Clutch counts obtained from seven hatched or freshly laid nests ranged from 86 to 138 (Table 2), which falls within the range of 50 to 147 reported by Cogger & Lindner (1969) and Limpus *et al.* (1983a). The mean clutch size, egg diameter and egg mass from a sample of the three nests in this study are similar to those recorded for this species in the northern hemisphere (Hirth 1980) and other Australian Ridley populations (Cogger & Lindner 1969; Limpus *et al.* 1983a). The mean straight carapace length of hatchlings (Table 3) is similar to those recorded from Cobourg Peninsula (42 mm to 46 mm) (Cogger & Lindner 1969) and Gulf of Carpentaria (45 mm) (Limpus & Roper 1977) and the northern hemisphere (Hirth 1980).

Although no evidence of Hawksbill nesting was found, some of the supposed Ridley tracks may have belonged to this species as their tracks are similar in size and symmetry. It is hoped that further research into the preferred nesting seasonality and localities of the sea turtle species of the Northern Territory will be initiated by this survey.

Conservation

The Ridley turtle is exceedingly widespread in the tropical waters of the Pacific, Indian and South Atlantic Oceans (Pritchard 1977), but has received little scientific attention in Australian waters, due in part to its nesting being restricted to the islands of northern Australia. The islands of Arnhem Land are the major nesting areas of this species in Australian waters, yet in this remote and largely uninhabited part of Australia's coastline evidence of plastic and other nondegradable debris was all too obvious. The remains of fishing gear and general refuse along the beaches were clearly generated by maritime activities in the Arafura Sea and in no way an indictment of the aboriginal owners of the islands. The remains of a bituminous oil slick on Cape Wessel was a reminder of the proximity of the shipping lane to the north. The likely detrimental impacts of such pollution and debris on sea turtles are reviewed by Carr (1987). Although no evidence of death by contact with human waste was observed during the survey, the large amount of material washed onto the beaches is cause for concern. The transit of the survey crosses part of the northern prawn fishery. The mortality of turtles as incidental bycatch of the fishery was estimated to be low (Limpus (1982) and quantified at 6% of all turtles (mainly Flatback and Ridley) caught in nets (Poiner *et al.* 1990).

The main threat to Ridley populations in the Northern Territory is the increase in human population pressure on the coastal resources (Cogger & Lindner 1969). Any conservation measures employed to protect Flatback nesting beaches will probably ensure the survival of the Ridley turtle as well (Cogger & Lindner 1969). It is now widely recognized that the thermal environment of the nest is an important component in turtle management strategies. The pivotal temperature, that which provides equal numbers of males and females in a clutch, has been

determined at 30° C for Ridley populations in Costa Rica (McCoy *et al.*1983). Significantly the major Ridley rookeries in this survey (Cape Wessel, Grant I and New Year I) had lower sand temperatures than those of N. W. Crocodile I where Flatback nests were more numerous (Table 1). Although nothing is known of the pivotal temperatures of Australian Ridley and Flatback populations, each island in the study may produce a different proportion of males and females for the species that nest there. It is hoped that the proposed tourist development of these islands (Julius 1990) proceed cautiously until more is known of these turtle species and their reproductive biology.

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New Locality Records of Birds in Arnhem Land and Southern Gulf of Carpentaria

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Introduction

The geographic distribution of bird species in remote regions of Arnhem Land and the southern Gulf of Carpentaria coast is inadequately documented. The avifauna of these regions is described in general terms by the RAOU Atlas (Blakers *et al.* 1984) and in lists by Storr (1977, 1984). Although a great deal is now known about the birds of Kakadu National Park (Woinarski *et al.* 1989a,b; Braithwaite & Woinarski 1990), the almost total lack of ornithological exploration in adjacent Arnhem land has led to possibly exaggerated claims of the significance of the Park as a refuge for many species. Here we report a number of significant new locality records for 17 species, including four of the eight species classified as "notable" (rare or endangered) by Woinarski *et al.* (1989a).

New records were obtained during the course of several brief avifaunal surveys. Four localities in Arnhem Land (Mann R, Goomadeer R, East Alligator R and Deaf Adder Creek; Fig. 1) were visited by helicopter during a study of the White-throated Grasswren *Amytornis woodwardi* from 26 December 1987 to 3 January 1988 (Noske 1988). The Lagoon Creek Gorge locality in north-west Queensland was visited to study the Carpentarian Grasswren *A. dorotheae* discovered there in 1986, documented recently by McKean & Martin (1989). Observers responsible for each record (the authors plus David Stewart: Mullumbimby, NSW; John McKean, Keith Martin: Darwin) are identified by their initials. Species designated as "notable" by Woinarski *et al.* (1989a) are identified by an asterisk. Latitudes and longitudes of all localities mentioned in the list are given in Appendix 1.

Annotated List of Species

RED GOSHAWK *Erythrotriorchis radiatus* *

- Robinson R crossing near 'Greenbank', 1 female, 1.7.86, flying downstream (GH, DS).
- Mann R camp, 1 male, 27.12.87, pursuing unidentified bird (GH).

The first record shows that no gap in distribution exists in the southern Gulf region, as predicted by Blakers *et al.* (1984).

BUSH-HEN *Amaurornis olivaceus*

- Caranbirini Waterhole south-west of Borroloola, 1, 29.6.86, calling early morning (GH).
- Plum Tree Creek crossing, 1, 21-23.12.87, calling late at night or early morning (GH).

There seem to be no published records for the southern Gulf region (see Blakers *et al.* 1984), but there is a previous unpublished record at Caranbirini Waterhole

(G Chapman, *in litt.*, 25.5.86). Although not listed by Woinarski *et al.* (1989a), the Plum Tree Creek record represents the second for Kakadu NP Stage III (see McKean & Reed 1979).

BANDED FRUIT-DOVE *Ptilinopus cinctus* *

- Nabarlek, groups of 2-7, 11-20.4.79, in fig trees, north and west of mine site; disused nest located 5 m above ground in horizontal fork of small tree in closed forest (GH).
- Mann R camp, 1, 27.12.87, river gorge in *Ficus virens* (GH, RN).

The second record is at or near the eastern limit (see Blakers *et al.* 1984). Note that the limits described by Reader's Digest (1986) as 'between Oenpelli and Katherine' are excessively conservative.

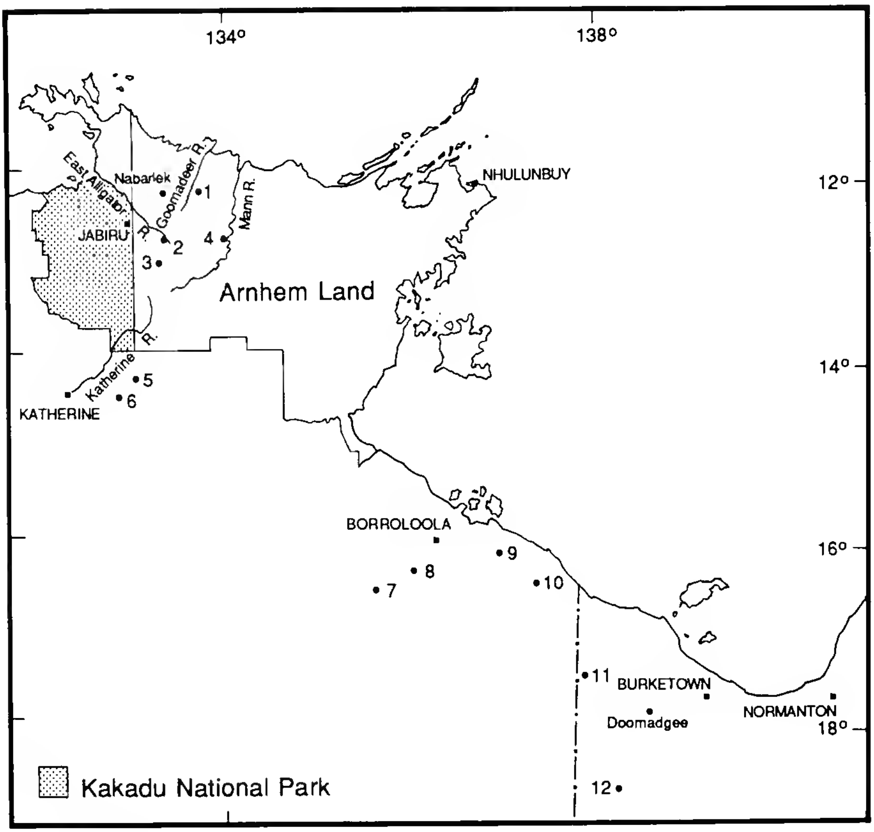

FIGURE 1 *Map of the region covered in this paper. Numbers refer to the following localities: 1, Goomadeer R; 2, East Alligator R; 3, Deaf Adder Creek; 4, Mann R; 5, Diamond Creek; 6, Maranboy; 7, Cape Crawford; 8, Glyde R; 9, Robinson R; 10, Calvert R, 11, Lagoon Creek Gorge; 12, Lawn Hill National Park.*

CHESTNUT-QUILLED ROCK-PIGEON *Petrophassa rufipennis*

- Nabarlek, singly or pairs, 11-20.4.79, encountered widely in sandstone areas; two occupied nests, each with two young, located in isolated outcrops, 6 m and 20 m above surrounding ground level, one in a horizontal crevice, the other in a pear-shaped cavity (GH).
- Diamond Creek via 'Eva Valley', 1, 19.12.87 (RN, GH).
- Mann, Goomadeer, East Alligator and Deaf Adder camps, singly or pairs, 26.12.87 - 3.1.88, encountered widely in sandstone areas (GH, RN).

Most of these records help define north-eastern and south-eastern limits; the record at Diamond Creek seems the first from this 1° block (see Blakers *et al.* 1984). Note that the limits described by Reader's Digest (1986) as 'vicinity of Oenpelli to Katherine Gorge' are excessively conservative.

RUFOUS OWL *Ninox rufa* *

- Deaf Adder Creek camp, 1-2, 3.1.88, calling before dawn (GH).

This record helps define the distribution in the interior of Arnhem Land (see Blakers *et al.* 1984).

RAINBOW PITTA *Pitta iris*

- Mann R camp, 2 singly, 27.12.87, calling from closed forest in river gorge (RN, GH).

This record is probably at or near the eastern limit on the Arnhem Land escarpment; suitable habitat farther east diminishes rapidly (pers. obs.). Near the coast it occurs east to Groote Eylandt (Storr 1977; Blakers *et al.* 1984).

RED-CAPPED ROBIN *Petroica goodenovii*

- Harris Lake south of Burketown, 1 male, 3.7.86 (GH).

This record is the first in the coastal Gulf region; birds have been observed in autumn and winter north to the Barkly Tableland and Mt Isa district (see Storr 1977, 1984; Blakers *et al.* 1984).

CRESTED (NORTHERN) SHRIKE-TIT *Falcunculus frontatus whitei*

- Maranboy, 3 km along Eva Valley road, 1 male, 18.12.87, woodland dominated by *Eucalyptus latifolia, E. tectifica* and *Melaleuca viridiflora* (GH, RN)

There have been few recent records of this subspecies (see Blakers *et al.* 1984). The location is 24 km from Leach's Lagoon where the species was seen in 1970 (Rix 1970). The habitat of half-barked bloodwoods and boxes is somewhat different from the "stringybark forest" given in Storr (1977).

LITTLE SHRIKE-THRUSH *Colluricincla megarhyncha*

- Truganini Landing east of Burketown, 1, 3.7.86, mangroves along Albert River (GH).

This record supports the first in this region during the RAOU Field Atlas (see Blakers *et al.* 1984).

SANDSTONE SHRIKE-THRUSH *C. woodwardi*

- Lawn Hill National Park, several, 25.6.86 (GH, DS).
- Lagoon Creek Gorge, several, 27.6.86 (GH, DS).
- Calvert R, 1 km downstream from crossing near 'Pungalina', 1-2, 1.7.86 (GH, DS).
- Diamond Creek via 'Eva Valley', several, 18-19.12.87 (GH, RN).

- Mann, Goomadeer, East Alligator and Deaf Adder camps, numerous, 26.12.87-3.1.88 (GH, RN).

These records extend the known distribution by including four 1° blocks not recorded by the RAOU Field Atlas (see Blakers *et al.* 1984). The extreme extension to Lawn Hill National Park was reported briefly by McKean & Martin (1989) and referred to vaguely by Storr (1984).

SPINIFEX-BIRD *Eremiornis carteri*

- Lagoon Creek Gorge, 1-2, 27.6.86, spinifex in sandstone foothills (GH).
- Glyde R, junction with McArthur R, 5.86 (JM, KM)

These records are the first from the coastal Gulf region and represent a considerable extension northward from the Mt Isa district (see Blakers *et al.* 1984; Storr 1984).

WHITE-THROATED GRASSWREN *Amytornis woodwardi* *

- Mann, Goomadeer, East Alligator and Deaf Adder camps, abundant in suitable habitat, 27.12.87 - 2.1.88 (RN, GH).

The Mann R record extends the known distribution of this species 100 km eastwards (from Nabarlek). The Field Atlas record for this 1° block (12°/134°) was based on second-hand information that was not confirmed (K. Bartram, pers. comm.). The designation of this species as "notable" by Woinarski *et al.* (1989a) is perplexing, considering Noske (1988) concluded that it was secure (see also Storr 1977; Schodde 1982).

HELMETED FRIARBIRD *Philemon buceroides*

- Lagoon Creek Gorge, 1, 27.6.86, chasing other honeyeaters (including Silver-crowned Friarbird *P argenticeps*) from a flowering *Grevillea pteridifolia* (DS, GH).
- Diamond Creek via 'Eva Valley', 1-2, 19.12.87 (GH,RN).
- Mann, Goomadeer, East Alligator and Deaf Adder camps, uncommon, 27.12.87-2.1.88 (GH, RN)

The first record is situated in the centre of an enormous gap in its documented distribution, between north-eastern Arnhem Land and northern Cape York Peninsula (see Blakers *et al.* 1984; Storr 1977, 1984). Despite its occurrence in sandstone habitat, a well developed casque on this bird indicates that *P. b. ammitophila* is not the subspecies concerned. The other records help better define the distribution of *ammitophila* in Arnhem Land, although all 1-degree blocks involved were recorded by the RAOU Field Atlas.

WHITE-LINED HONEYEATER *Meliphaga albilineata*

- Mann, Goomadeer, East Alligator and Deaf Adder camps, numerous, 26.12.87-3.1.88 (GH, RN).

These records (especially the first) extend the known distribution in the interior of Arnhem Land (see Blakers *et al.* 1984; Reader's Digest 1986).

ORANGE CHAT *Ephthianura aurifrons*

- Doomadgee, Nicholson R crossing, 1 pair, 26.6.86 (DS, GH).
- Borroloola, 3 km south-west, 3, 3 and 5, 29.6.86 (GH, DS). Also recorded here in 1985 (J. Whitaker per JM).
- Harris Lake south of Burketown, 2, 3.7.86 (GH).

PLATE 2 *White-throated Grasswren in the hand, Kakadu National Park (R. Noske)*

These records indicate that winter visitors may occur regularly in the coastal Gulf region; the only previous record was at Burketown (see Blakers *et al.* 1984).

PAINTED FIRETAIL *Emblema picta*

- Lawn Hill National Park, numerous, 25-26.6.86 (GH, DS).
- Lagoon Creek Gorge, 4-5, 27.6.86 (GH, DS).

These records extend the documented distribution northward from the Mt Isa district (see Blakers *et al.* 1984; Storr 1984). There are also two unpublished records, of two birds at Katherine Gorge National Park in May 1985 (David Kowalick per JM), and an unknown number near Cape Crawford (90 km SW of Borroloola) in May 1986 (JM).

LITTLE CROW *Corvus bennetti*

- Borroloola, 20 km north on 'Bing Bong' road, several, 30.6.86 (GH, DS).

This is the first record from the coastal Gulf region of the Northern Territory (see Blakers *et al.* 1984; Storr 1977).

Discussion

Recorded distributional limits were extended considerably for several species or populations associated closely with sandstone outcrops. Accordingly, perceptions that species such as the Banded Fruit-Dove, Chestnut-quilled Rock-Pigeon and White-throated Grasswren are confined to the escarpment region within Kakadu National Park are incorrect. Of the four species classified as "notable" by Woinarski *et al.* (1989a), two (Rufous Owl and White-throated Grasswren) appear to be neither rare nor endangered based on information published here and elsewhere.

Another (Banded Fruit-Dove) is apparently not as restricted as previously thought, and also occurs in the Lesser Sunda Islands. Clearly further exploration of Arnhem Land is necessary before the distribution and status of the birds of this region can be accurately assessed.

Acknowledgements

The White-throated Grasswren study was funded by the Australian National Parks and Wildlife Service. We thank Dr Tony Press (ANPWS) for his supervision of that work, and Mr Carl Spann (Rotor Services) for providing transport to Arnhem Land. The Northern Land Council issued permits to travel and work within Arnhem Land, and Beswick Aboriginal Land. We are also grateful to Hilary Thompson, John McKean, Keith Martin and Mike Reed for supplying their unpublished records, and to Cecilia Adams for the artwork.

PLATE 3 *Helmeted Friarbird, Darwin (R. Noske)*

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APPENDIX 1 Latitudes and longitudes of localities mentioned in the text, listed alphabetically.

Borroloola, 3 km south-west (16°05'S, 136°17'E)
Borroloola, 20 km north on 'Bing Bong' road (15°55'S, 136°19'E)
Calvert R, 1 km downstream from crossing near 'Pungalina' (16°31'S, 137°32'E)
Cape Crawford (16°39'S, 135°47'E)
Caranbirini Waterhole south-west of Borroloola (16°26'S, 136°04'E)
Deaf Adder Creek (13°07'S, 133°16'E)
Diamond Creek via 'Eva Valley' (14°14'S, 133°04'E)
Doomadgee, Nicholson R crossing (17°58'S, 138°51'E)
East Alligator River (12°49'S, 133°19'E)
Goomadeer River (12°17'S, 133°40'E)
Harris Lake south of Burketown (17°49'S, 133°33'E)
Glyde R, junction with McArthur R (16°25'S, 136°08'E)
Lagoon Creek Gorge (17°32'S, 138°02'E)
Lawn Hill National Park (18°44'S, 138°28'E)
Mann River (12°47'S, 134°04'E)
Maranboy, 3 km along "Eva Valley" road (14°30'S, 132°48'E)
Nabarlek (12°19'S, 133°19'E)
Plum Tree Creek crossing (13°31'S, 132°27'E)
Robinson R crossing near 'Greenbank' (16°16'S, 137°05'E)
Truganini Landing east of Burketown (17°45'S, 139°35'E)

Wet Season Occupation of Workshop Jungle by Small Mammals

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Abstract

Small mammals at eight sites within Workshop Jungle, Fogg Dam Nature Reserve, were trapped over a 13 day period (2 080 trap nights) in the wet season of 1988/89. Three species were caught, in order of decreasing abundance, *Rattus colletti*, *Planigale maculata*, and *R. tunneyi*. Unlike *R. tunneyi* and *Planigale maculata*, the number of individuals of *R. colletti* was inversely related to elevation, possibly because this species forages in shallow flood water at the foot of the slope. Compared to Cape York the small mammal fauna of this forest is depauperate, and contains no rainforest specialists.

Introduction

Workshop Jungle is situated within the Fogg Dam Nature Reserve some 50 km south east of Darwin. It is a relatively large patch (about 2 km^2) of monsoon forest that has been classified as a semi-deciduous notophyll vine forest on fluviatile deposits (Kikkawa *et al.* 1981). Bowman & McDonough (1991) have made a detailed study of the spatial pattern of trees across the slight elevation gradient above the seasonally flooded sedgelands on the Adelaide River floodplain. Vegetation pattern on these sedgelands has been described by Bowman & Wilson (1986).

The seasonal dynamics of the herpetofauna and pig rooting of Workshop Jungle have been described by Martin & Freeland (1988) and Bowman & McDonough (unpubl. data) respectively. To date there have been no studies of other vertebrate groups in this jungle. To redress this imbalance we undertook a small mammal survey during the wet season of 1988-1989.

Methods

In the 13 day period from 23 December 1988 to 4 January 1989 small mammals were trapped in eight 50 x 50 m plots within Workshop Jungle. Plots were selected from a grid established by Bowman & McDonough (1991) to cover the full range of altitudinal variation within the monsoon forest. A 10 x 20 m quadrat was used to sample the total basal area, richness and stem density of woody species >2 m height within each plot. The entire grid was surveyed to determine the height above mean sea level of the south east corner of each plot relative to Australian height datum. Bores were established to find the height of the water table in February 1989.

The trapping regime consisted of four 20 m trap lines spaced 10 m apart. On each trap line five medium-sized Elliott traps were placed at 4 m intervals. Traps were baited with a mixture of peanut butter, oats and honey. Traps were checked at first light and rebaited and set each afternoon. Trapped animals were sexed,

TABLE 1 *Pearson correlation coefficients between measured environmental variables and total number of individuals of the three small mammals caught at the eight sites at Workshop Jungle (*p<0.05; **p<0.001; ***p<0.001).*

	Elevation	*R. colletti*	*R. tunneyi*	*P. maculata*
Elevation	1.00	-0.92 ***	0.21	0.16
Basal area of trees	-0.73 *	0.74 *	0.21	0.43
Density of trees	-0.71 *	0.73 *	-0.54	-0.24
Tree species richness	0.74 *	-0.58	0.35	0.14
Watertable depth	-0.88 **	0.81 *	-0.16	0.19

weighed and measured (tail, head and body length), their ears marked with numbered tags and then released.

Results

Three species of small mammals (two rodents and one dasyurid) were caught. *Rattus colletti* was the most abundant species (n = 144), while *Rattus tunneyi* (n = 18) and *Planigale maculata* (n = 24) had a similar and much smaller number of individuals (Fig. 1). There was no relationship between the number of *R. colletti* and the numbers of the other two species (*R. tunneyi*, $r = 0.24$, $p = 0.57$; *P. maculata*, $r = 0.03$, $p = 0.94$; $n = 8$ sites).

The number of *R. colletti* individuals was strongly related to the elevation of the plot (Fig. 1). Such a relationship was not apparent for the two other species of small mammal. Table 1 shows that elevation is related to all the other measured habitat variables, most of which are also correlated with number of *R. colletti.*

Discussion

Despite the intensive trapping effort only three species of mammal were captured. None of these are rainforest specialists: all are known to occur in a variety of other habitats in northern Australia (Strahan 1983). Detailed studies of *R. colletti* (Redhead 1979; Friend *et al.* 1988) and *P. maculata* (Taylor *et al.* 1982) show that they seasonally migrate up the elevation gradient from the sedgelands into surrounding habitats to avoid wet season flood waters. *Rattus colletti* prefers sites near to the edge of the flood waters, possibly so it can forage in shallow water (Williams 1983). The other two species appear to be randomly distributed through the monsoon forest.

The trapping occurred during a wet season with above average rainfall (Bowman & McDonough 1991). It is unclear what influence this has had on results of the study. For example, *Melomys burtoni* which has been previously recorded for this Jungle (K. Martin, J. Estbergs, pers. comm.) was not caught. Similarly it is known that *R. colletti* populations vary dramatically in response to rainfall events (Friend *et al.* 1988). These authors suggest that buffalo destocking may result in a wetland-forest transition that is more favourable for this species.

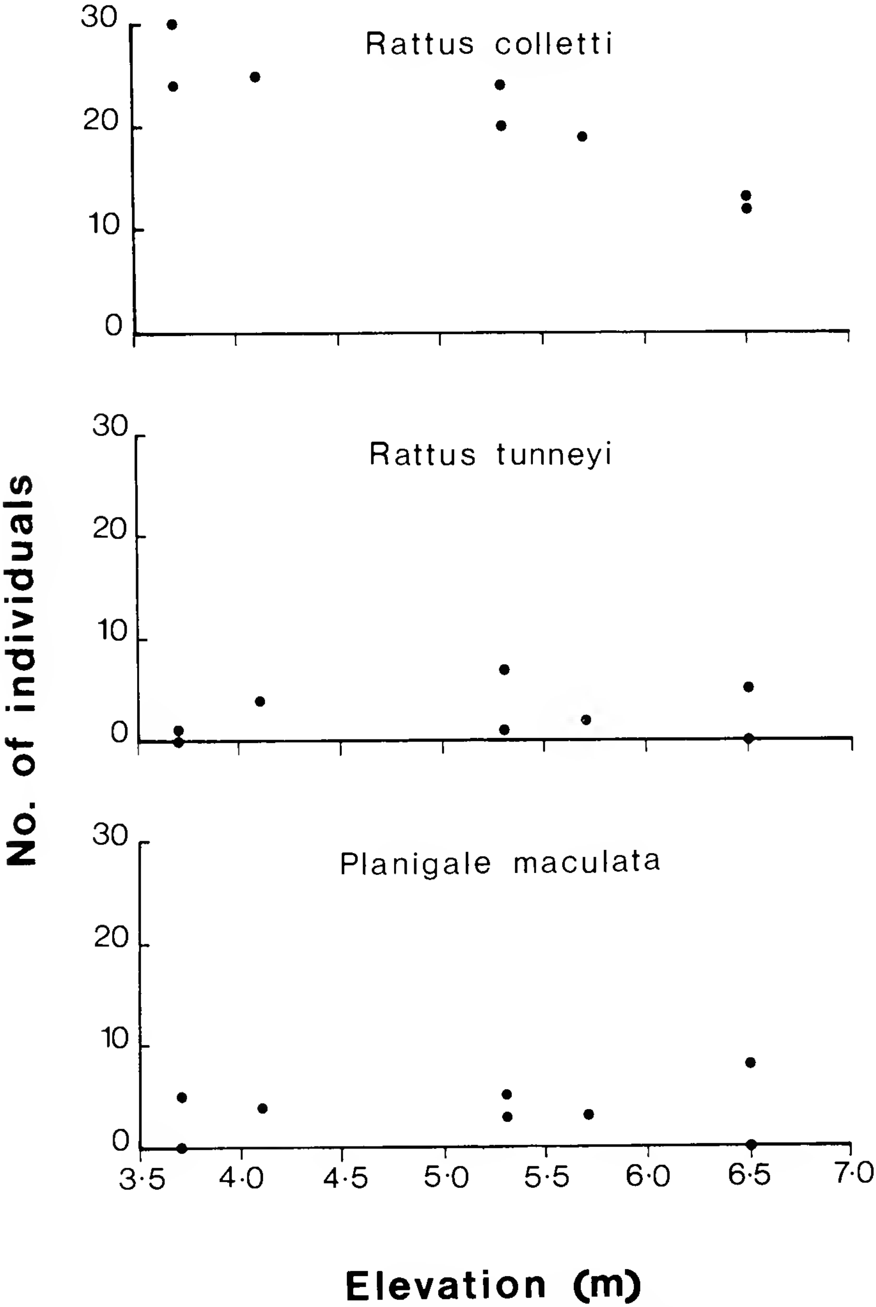

FIGURE 1 *Relationship between elevation and the total number of individuals of the three species of small mammal caught at the eight sites within Workshop Jungle.*

The Northern Territory is known to have few specialist rainforest vertebrates (Martin & Freeland 1988; Woinarski 1989). Winter (1988) reports that there are four small mammal rainforest specialists that occur on Cape York and suggests that this relative richness is most probably due to large areas of rainforest that provided refugia during periods of aridity, while in south-eastern Australia the rainforest pockets contracted below a critical size to support rainforest specialists. This argument might also explain the absence of rainforest specialists in the NT.

Acknowledgements

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Seed Dispersal of Black Wattles *Acacia auriculiformis* by Birds

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Acacia is Australia's largest genus of Australian flowering plants yet its seed dispersal is poorly understood. Recent studies have shown that there are three distinct seed dispersal "syndromes" (Davidson & Morton 1984; O'Dowd and Gill 1986): ant-dispersed arillate species, bird-dispersed arillate species, and abiotic-dispersed non-arillate species. The seeds of bird-dispersed wattles tend to have large, colourful (yellow to red), lipid-rich arils, and are retained in the canopy, while those of ant-dispersed species typically have smaller, whitish, lipid-poor arils and are presented inconspicuously on the ground. Colourful arils are more likely to attract avian dispersal agents since birds, in contrast to insects, have well developed colour vision, often showing preferences for red and yellow (see Davidson & Morton 1984, Ford & Paton 1986). Research on both *Acacia* seed dispersal and frugivorous birds has to date been concentrated in the arid and temperate zones.

The Black or Ear-pod Wattle *A. auriculiformis* is widely distributed in the Top End (Brock 1988; Wightman & Andrews 1989), and is a common street and garden tree in Darwin (Hearne 1975). One of the distinctive characteristics of the species is the long bright orange aril by which each of the black seeds hangs from the pod. I observed passerine birds of ten species (Table 1) feeding on the arils of large *A. auriculiformis* in Darwin on seven separate occasions between March and August (mostly July), 1986-89 inclusive. These species vary considerably in size and diet, and four are principally Dry Season visitors to the Top End (Table 1). Only the Figbird and the two orioles are primarily frugivorous.

In most cases the birds were observed to pluck the aril with its attached seed, then shake or bash it on a branch before ingestion took place. In two instances clumps of detached seeds and aril fragments were found on the ground directly below the feeding site. A Black-faced Cuckoo-shrike also fed on detached arils from the road below one tree. Birds appeared to swallow the seed along with the aril on several occasions. Such seeds would probably pass through the gut in tact (see Forde 1986) but no seed-containing scats were found in the course of my observations.

Davidson & Morton (1984) predicted bird dispersal for *A. auriculiformis* based on its bright aril colour, and this is supported by my observations. The measurements given for this species in O'Dowd and Gill (1986) also strongly suggest ornithochory. Of the 92 species of *Acacia* they examined, only 10 possessed arils longer than 20 mm and 14 had arils with a lipid content of over 50%; *A. auriculiformis* arils averaged 24 mm in length and had a lipid content of 55%. Moreover, investment in dispersal per diaspore (seed plus aril) was 15%, much closer to the average value for bird-dispersed species than for ant-dispersed species (19 vs 7% respectively).

TABLE 1 *List of species observed feeding on arils of* A. auriculiformis

Species	*Size (cm)*	*Food**	*Status †*
Black-faced Cuckoo-shrike *Coracina novaehollandiae*	33	I, F	Dry
White-bellied Cuckoo-shrike *C. papuensis*	26	I, F	Year-round
Varied Triller *Lalage leucomela*	20	I, F	Year-round
White-winged Triller *L. seuerii*	18	I	Dry
Rufous-banded Honeyeater *Conopophila albogularis*	13	I, N	Year-round
White-gaped Honeyeater *Meliphaga unicolor*	20	I,F,N	Year-round
Figbird *Sphecotheres viridus*	27	F	Year-round
Yellow Oriole *Oriolus flavocinctus*	27	F,(I)	Year-round
Olive-backed Oriole *O. sagittatus*	26	F,(I)	Dry
White-breasted Woodswallow *Artamus leucorhynchus*	17	I	Dry

* I, insects; F, fruit; N, nectar

† Season of greatest abundance in the Darwin region (Thompson & Goodfellow 1987; pers. obs.)

O'Dowd and Gill (1986) suggest that the present predominance of ant-dispersed *Acacia* in Australia may be a result of the nomadic habits of many avian frugivores, and the greater reliability of ants. *Acacia auriculiformis* is possibly exceptional among its congeners in that it grows most abundantly in coastal and lowland monsoon vine forests, and along perennial watercourses (Wightman & Andrews 1989). These habitats are patchily distributed and often separated by long distances. They are also the main habitats of figbirds, orioles and other frugivorous birds. Moreover the ant faunas of vine forests are impoverished relative to savannas (A. Andersen, pers.comm.). Thus *A. auriculiformis* probably benefits from the long distances travelled by birds, especially flocks of figbirds, between patches of vine forests. Bird dispersal might also account for the pioneering tendency of this species (e.g. Wightman & Andrews 1989). The efficiency of bird dispersal in *A. auriculiformis* would provide a fruitful area of research.

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SHORT NOTES

Observations of Turtles and Birds on Bare Sand Island

Bare Sand Island (12° 32' S, 130° 25' E) lies 80 km to the west of Darwin, and is approximately 19 ha in area. It is a well-known destination for members of Darwin's yachting community who regularly overnight on the island during the dry season (May to October) when trade winds are from the south east. Many visitors to the island have reported turtle nesting and have sighted either adult turtles ashore at night, or hatchlings on the beach. The island is mentioned by Mr. Hugh Christie (Fry 1913: *Rec. Aust. Mus.* **10**, 159-85) who at one time manned the lighthouse at Charles Point, as a near year-round nesting locality for the Flatback Sea-turtle, *Natator depressus*. In view of the published and anecdotal reports, we visited Bare Sand Island on 16 December 1989, for 24 hours to document the extent of sea turtle nesting.

After an initial walk around the island, we concluded that there had been no nesting by sea-turtles for some weeks and possibly, even months. There was no sign of turtle tracks, or recently hatched nests, both of which leave characteristic depressions in the sand. However we found the remains of turtle egg shells of past seasons exposed by the erosion of the dunes by wind and waves. The estimated diameter of the eggs (52 mm), and their depth of burial (50 cm) indicated that Flatbacks were responsible. The presence of Flatbacks was established when the carcass of a hatchling, minus the head and limbs, was found at the base of the lone tree. As the remains of fish accompanied the hatchling it is assumed that the turtle was carried there by a predatory bird.

Birds were abundant on the island. Species with the largest numbers were Crested Terns *Sterna bergii* (1,000), Lesser Frigatebird *Fregata ariel* (100), and Black-naped Tern *Sterna sumatrana* (40). The nests of Black-naped Terns were common in bomb craters on the western side of the island. These craters, in which the remains of twisted steel and schrapnel were found, were evidence that the island had been heavily bombed at some time in the past. The only previously known breeding sites of the Black-naped Tern in Northern Territory waters are to the east of Darwin (Cobourg Peninsula and Gove), so the Bare Sand Island rookery represents a new breeding locality (H. Thompson, pers. comm.). A low spreading shrub supported numerous nests of Reef Herons *Egretta sacra*. Twelve adults and eight recently-fledged juveniles were counted, including both white and dark colour phases. Only three nests contained chicks (Plate 1). Other birds observed on the island, and their approximate numbers, were as follows: Australian Pelican *Pelicanus conspicillatus* (30), Brown Gannet *Sula leucogaster* (1), Brahminy Kite *Haliastur indus* (2), White-breasted Sea-eagle *Haliaeetus leucogaster* (2), Beach Thick-knee *Burhinus neglectus* (2), Sooty Oystercatcher *Haematopus fuliginosus* (2), Silver Gull *Larus novaehollandiae* (6).

PLATE 4 *Young Reef Herons in nest on Bare Sand Island (P. Ryan)*

Bare Sand Island is an interesting locality for beach-combing as a good variety of shells and the tests of large sand dollars are plentiful along the shore. Inland the partially fossilised tests of heart urchins and shells are abundant in the craters along the western coast. The area including Bare Sand Island is presently under the Kenbi Land Claim by the Larrakeyah people. What ever the outcome it is hoped that access to the island will not be denied by either the traditional owners or leaseholder.

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Notes on Reproduction in the Skink *Sphenomorphus darwiniensis*

Sphenomorphus darwiniensis, a skink endemic to the Top End of the Northern Territory and the northern Kimberley of Western Australia (see Storr 1967 and Storr *et al.*, 1981) has been inferred to be reproductively active during the Wet Season, and quiescent during the Dry (James & Shine 1985, as *S. crassicaudus*). This inference was based on seven adult males and five adult females. However, only one female was actually reproductively active; it measured 52 mm in snout-vent length (SVL), had a clutch size of five and was collected in January (James 1983, as *S. crassicaudus*). The mode of reproduction was implied ("clutch size"),

but was not stated to be oviparous. The recent discovery of four gravid females in the collections of the Queensland Museum (QM J34827-29, 34866) provides additional information on reproduction, and reinforces the original inferences as to the seasonality and mode of reproduction in the species.

The four females each carried three shelled oviducal eggs (two in the right oviduct and one in the left), and were collected on 27 and 30 December 1978 at Beatrice Hill, NT. The summary statistics for these four females plus the one previously reported are: SVL 42-52 mm (*mean* = 46, *sd* = 4.7) and clutch size 3-5 (*mean* = 3.4, *sd* = 0.9).

These observations taken in conjunction with the earlier one suggests that female *S. darwiniensis* are sexually mature at a SVL of at least 42 mm, are oviparous with a variable clutch size of at least 3-5, and are reproductively active with oviducal eggs during the early to mid Wet Season (Dec - Jan).

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A Note on Diving Behaviour in the Northern Sand Goanna *Varanus panoptes*

The Northern Sand Goanna *Varanus panoptes* is a large species which is common in a variety of woodland and grassland habitats across northern Australia (Wilson & Knowles 1988). Little information has been published on the habitat requirements of this species, but it is frequently encountered along small watercourses in the Top End. The following observations were made on an individual of this species during the course of a fish population study at a small creek near Nabarlek, in western Arnhem Land.

At approximately 2.00 pm on 9 May 1990, a small (0.5 m total length) *V. panoptes* appeared at the edge of the creek, about ten metres downstream of my position. As I was at that time sitting quietly by the bank in a grassy area, I was confident that the goanna was unaware of my presence. The creek was about seven metres wide and 0.6 m deep, and was exceptionally clear, with a sandy bottom. The goanna slid into the creek, swam to the bottom, then crawled upstream along the bottom for about ten metres, to a point opposite my location. There, it stopped, and remained motionless on the bottom. During this time, I noticed that the goanna's eyes were closed.

Exactly ten minutes after submerging, the goanna slowly crawled up the bank and surfaced. It was still apparently unaware of my presence. After a couple of

minutes on the surface, the goanna turned and submerged once again, this time crawling along the bottom of the creek in a more determined manner.

The goanna appeared to be searching for food on the bottom. It methodically worked its way along the undercut bank of the creek, poking its head into any holes encountered. During this activity the eyes remained closed, but the tongue was occasionally flicked. At one point, it encountered a large submerged log. It crawled under this log and remained out of sight for several minutes. It then continued its downstream journey, and re-surfaced some 20 m downstream of my location, once again exactly ten minutes after submerging. After the next dive it was not re-sighted.

Varanus panoptes is not generally considered to be a semi-aquatic species, and certainly has none of the adaptations present in the truly semi-aquatic monitors *V. mertensi* and *V.mitchelli*, such as the extreme lateral compression of the tail, and the high positioning of nostrils. Both of these semi-aquatic species are present in the same area where these observations were made, *V. mitchelli* being the more common of the two.

My interpretation of these observations is that the goanna was searching for food in the creek. Crustaceans such as the Freshwater Crab *Holthusiana transversa* and the Crayfish *Cherax quadricarinatus* occur in this creek (pers. obs.), as well as a number of fish species, and these may form part of the goanna's diet in this area. The fact that both observed dives were of the same duration suggests that this may be near the comfortable breath-holding limit for this species.

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